Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: CH202

Course Name: PROCESS HEAT TRANSFER (CH)

Max. Marks: 100 Duration: 3 Hours

(Use of reference books or Data Book is not permitted)

PART A

Answer any two question, each carries 15 marks Marks

1 a) What are the basic modes of heat transfer? State the phenomenological laws in each mode of heat transfer. Write the relevant equations. (5)

b) The wall of a building is a multi-layered composite consisting of brick (100-mm layer), a100-mm layer of glass fiber, a10-mm layer of gypsum plaster, and a 6-mm layer of pine panel. If h_{inside} is $10 W/m^2.K$ and $h_{outside}$ is $70 W/m^2 K$, Calculate the total thermal resistance and the overall coefficient for heat transfer. Also determine the interface temperatures. (10)

Properties: T= 300K,Thermal conductivity o f : Brick = 1.3 W/m.K, Glass fiber= 0.038W/m.K, Gypsum = 0.17W/m.K, Pinepanel=0.12W/m.K.

2 a) What is the significance of Heisler charts? (7)

b) The inside surface of a brick wall (k = 1 W/m-K) of 10 cm thicknessis at a temperature of 930°C and the outside surface is exposed to ambient air at 30°C providing a heat transfer coefficient of 20 W/m^2-K. Calculate the temperature of the outside surface. Calculate the thickness of insulation (k = 0.1 W/m-K) that is needed so that outside surface surface temperature exposed to air will not exceed 90°C (8)

3 a) Define is thermal diffusivity. Give its significance? Write its units in SI system. (3)

b) Give the significance of Biot number or Biot modulus. (2)

c) A thermocouple junction, which may be approximated as a sphere, is to be used for temperature measurement in a gas stream. The convection coefficient between the junction surface and the gas is known to be h = 400 W/m^2.K and the junction thermophysical properties are k = 20 W/m.K, Cp = 400 J/kg.K, and ρ = 8500 kg/m^3. Determine the junction diameter needed for the thermocouple to have a time constant of one second. If the junction is at 25^0 C and is placed in a gas stream that is at 200^0 C, how long will it take for the junction to reach 199^0 C? (10)

PART B

Answer any two question, each carries 15 marks

4 a) Under what conditions is the Nusselt number associated with internal flow is equal to a constant value independent of Re and Pr. (2)

b) Give the merits and demerits of the different analogies in heat and momentum transfer. (3)

c) Using dimensional analysis, prove that heat transfer during forced convection can be represented by the relationship Nu = f (Re, Pr) (10)

5 a) Define Reynolds, Nusselt, Prandtl, Stanton, Grashof numbers (5)

b) Steam in the condenser of a power plant is to be condensed at a temperature of (10)

30^0C with cooling water, which enters the tubes of a condenser at 14^0C and leaves at 22^0C. The surface area of the tubes is $45m^2$ and the overall heat transfer coefficient is 2100 $W/m^2.^oC$. Determine the mass flow rate of the cooling water needed and the rate of condensation of steam in the condenser.
Properties: The heat of vaporization of water at 30^0C is 2431 kJ/kg, Specific heat of cold water at the average temperature of 18^0C is 4184 J/kg.^{0}C

6 a) State Stefan Boltzmann law, Plank's law and Wien's Displacement law (3)

b) Obtain the shape factor with respect to itself if the surface is concave, convex or flat. (6)

c) Derive the expression for the rate of heat transfer between two infinite parallel gray planes. (6)

PART C

Answer any two question, each carries 20 marks

7 a) Brig out the characteristics of pool boiling. (10)

b) Derive the expression for temperature distribution and heat flux for fin with insulated tip. (10)

8 a) Write the material and energy balances for a single effect evaporator. (4)

b) 1000 kg of dilute solutionof sodium hydroxide containing 10% NaOH is concentrated to 40% NaOH by mass in a single effect evaporator per hour. The feed temperature is 25^OC and boiling point of solution is 100^oC (10)

Data: Specific heat of solution=4.18 kJ/kgK
Latent heat of vaporization of water from solution=2240kJ/kg
Saturated steam at 1.8 bar and 117^oC is available for heating
Latent heat of condensing steam=2213kj/kg^oC
Overall heat transfer coefficient=1850 W/m^2-^oC
Calculate :
i) The quantity of water evaporated and quantity of steam used per hour
ii) Surface area of the evaporator required.

c) Give the different feeding arrangements of multi effect evaporator along with their merits and demerits. (6)

9 a) Derive the Nusselt equation for the average coefficient of heat transfer at the condensing film in a vertical cooled tube (10)

b) Saturated steam at 1.43 bar and 110^0C condenses on a vertical tube, 1.9 cm outside diameter and 20 cm long. The tube surface is maintained at a temperature of 109^0C. Calculate the average heat transfer coefficient and the local heat transfer coefficient at the bottom edge of the tube. (10)

Properties of water at the mean film temperature 109.5^0C
Density=951.4 Kg/m^3, k=0.685 W/m^2K, Viscosity=$260.1x10^{-6}$ Kg/ms,
Latent heat of condensation at 110^0C and 1.43 bar=$2230x10^3$ J/Kg

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